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**U.S. Army BTF Technical Contribution to M1.3 -
National and International Face Recognition Format for Data Interchange
Standards: Comparative Analysis Report**

Submitted by:

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1 Purpose

The purpose of this report is to provide a detailed comparison of the differences between the Face Recognition Format for Data Interchange national standard (ANSI INCITS 385-2004) and the Biometric Data Interchange Format – Part 5: Face Image Data international standard (ISO/IEC 19794-5:2005). The possibility of converting biometric data records from the ANSI INCITS format to the ISO/IEC format is discussed. This report also provides a detailed description of some potential defects in the original clauses of the two standards. Further, this report provides recommendations on a possible resolution of these differences as well as steps that can be taken to facilitate biometric data record conversion and future work in this area.

2 ANSI INCITS 385-04 vs. ISO/IEC 19794-5

The ANSI INCITS 385-2004 Face Recognition Format for Data Interchange and the ISO/IEC 19794-5 Biometric Data Interchange Format – Part 5: Face Image Data standards specify methods for creating biometric images of facial characteristics. These standards specify the structures of each facial image data format and the detailed definitions of each field that should be included in each facial image interchange data record.

2.1 Data Format Structures

Both data format standards have defined an identical structure for facial image interchange data. These formats contain one mandatory CBEFF¹ header record, one facial header, one or multiple facial records and corresponding image data, and one optional CBEFF signature record.

The organization of both record formats is as follows:

- A fixed-length (14 bytes) Facial Record Header containing information about the overall record, including the number of facial images represented and the overall record length in bytes;
- A Facial Data Record for each facial image. This record consists of:
 - A fixed-length (20 bytes) Facial Information block describing discernable features of the subject, such as gender.
 - Multiple (including none) fixed-length (8 bytes) Face Definition parameter Feature Points for the purpose of feature position interchange.
 - A fixed-length (12 bytes) Image Information block describing digital features of the image such as facial image type and dimensions, such as width and height.
 - Image Data consisting of a JPEG or JPEG 2000 encoded data block.

Table 1 shows the structure of a face image data interchange format containing “n” Face Data record blocks, where “n” is greater than or equal to 1.

¹ CBEFF header was required at the time of preparation of this report. There is an ongoing effort to remove any CBEFF requirements from the national Data Interchange Format standards, and it is expected that similar changes will be made in the future revisions of their international counterparts.

Table 1. Structure of Face Image Data Interchange Format

CBEFF Header
Facial Record Header
Face #1 Facial Information
Face #1 1 st Feature Point Data
...
Face #1 Last Feature Point Data
Face #1 Image Information
Face #1 Image Data
...
Face #n Facial Information
Face #n 1 st Feature Point Data
...
Face #n Last Feature Point Data
Face #n Image Information
Face #n Image Data
CBEFF Signature

2.2 Comparison Results

Tables 2, 3, 4, 5, 6, and 7 of ANSI INCITS 385-2004 have different values of flags/codes as compared to the contents of corresponding tables of ISO/IEC 19794-5. For example:

- The minimum Record length in section 5.4 of ANSI INCITS 385-2004 is 0 bytes; it should be 46 bytes (14 bytes of Facial Record Header + 20 bytes of Facial Information + 12 bytes of Image Information).
- The common definitions of X and Y coordinates from the upper left pixel of a digitized image are counted starting from (0, 0) not (1, 1).
- The facial image types of ANSI INCITS 385-2004 in section 5.7.1 (page 21) have “other” (value = 3) type option. From figure 7 (page 22) of ANSI INCITS 385-2004, the “Basic” type includes “Frontal” and “Other” types, and “Frontal” type includes “Full” and “Token” types. The “Frontal,” “Frontal/Full,” and “Frontal/Token” image types are defined in ANSI INCITS 385-2004 clauses 7, 8, and 9, respectively. The ANSI INCITS 385-2004 has no clause defining the “Other” type.
- The other detailed comparison results are described in Table 2.

The section 8.3.3 (Position of Eyes) of ANSI INCITS 385-2004 has no definition to cover the vertical position of the face that is captured from children under the age of 11. The ISO/IEC 19794-5 defines: An imaginary horizontal line through the center of the eyes shall be located between 40%

and 70% of the vertical distance up from the bottom edge of the captured image to cover the facial image that is captured from children under the age of 11 years.

The minimum image width in section 8.3.4 (Width of Head) of ANSI INCITS 385-2004 shall be specified by the (Image Width: Head Width) ratio (A:CC) of 7:4.

Table 2 lists the section level summary comparison results. There are 16 differences between the two standards. The bolded areas demonstrate the differences.

Table 2. Comparison Results between ANSI INCITS 385-2004 and ISO/IEC 19794-5

Item #	ANSI INCITS 385-2004		ISO/IEC 19794-5	
	Section/Table	Description	Section/Table	Description
1	5.1 (p. 6)	The face pattern record format is used to provide interoperability between uses of face recognition systems and digital face image storage systems. The record format contains face data discernable from the human examination of a face or face image, including gender and other categorizations that may be useful for search systems, and the face image intensity information itself in a compressed or uncompressed data representation. ...	5.1 (p. 5)	The face record format specified in this document is a format to store face image data within a biometric data record. ...
2	5.1 (p. 7)	There are no record separators or field tags; fields are parsed by byte count, and each item of information or block, shall contain one or more bytes of data.	5.1 (p. 6)	There are no record separators or field tags; fields are parsed by byte count.
3	5.4 Table 2 (p. 9)	Record length: Valid Values = $0 < \text{Record Length} \leq 2^{32} - 1$	5.4 Table 2 (p. 8)	Record length: Valid Values = $46 < \text{Record Length} \leq 2^{32} - 1$
4	5.5.3 Table 3 (p. 10)	Unknown: Value = 3	5.5.3 Table 3 (p. 9)	Unknown: Value = 0xFF
5	5.5.4 Table 4 (p. 11)	Unspecified = 0x00 Blue = 0x01 Brown = 0x02 Green = 0x03 Hazel = 0x12 Maroon = 0x22 Multi-colored = 0x10	5.5.4 Table 4 (p. 10)	Unspecified = 0x00 Black = 0x01 Blue = 0x02 Brown = 0x03 Gray = 0x04 Green = 0x05 Multi-coloured = 0x06

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		Pink = 0x20 Other or Unknown = 0xFF		Pink = 0x07 Reserved = 0x08 – 0xFE Other or Unknown = 0xFF
6	5.5.5 Table 5 (p. 12) Red = 0x06 Blue = 0x10 Green = 0x20 Orange = 0x30 Pink = 0x40 Sandy = 0x13 Auburn = 0x14 White = 0x15 Strawberry = 0x16 Unknown or Other = 0xFF	5.5.5 Table 5 (p. 11)	... White = 0x06 Red = 0x07 Reserved = 0x08 – 0xFE Unknown or Other = 0xFF
7	5.5.6 (p. 13)	Feature Mask	5.5.6 (p. 12)	Property Mask
8	5.5.6 Table 6 (p. 13)	Features are specified = 0 ... Both Eye Patch = 9 Dark Glasses (medical) = 10 Major Medical Condition (which could impact feature point detection) = 11 Reserved for future definition = 12-23	5.5.6 Table 6 (p. 12)	Properties are specified = 0 Dark Glasses (medical) = 9 Feature Distorting Medical Condition (which could impact Feature Point detection) = 10 Reserved for future definition = 11-23
9	5.5.7 Table 7 (p. 14)	Reserved for future definition = 1-127 (High Byte) and 0-255 (Low Byte)	5.5.7 Table 7 (p. 13)	Reserved for future definition = 0x00 (High Byte) and 0x08-0xFF (Low Byte); 0x01-0x7F (High Byte) and 0x00-0xFF (Low Byte)
10	5.6.3 Table 9 (p. 20)	X coordinate: Count starts at 1 Y coordinate: Count starts at 1	5.6 Table 8 (p. 16)	X coordinate: Count starts at 0 Y coordinate: Count starts at 0
11	5.7.1 Table 10 (p. 21)	... Other = 3 Reserved = 4-255	5.7.1 Table 10 (p. 19)	... Reserved = 0x03 – 0xFF
12	5.7.1 Figure 7 (p. 22)	“Basic type” includes “Frontal” and “ Other ”	5.7.1 Figure 8 (p. 20)	“Basic type” includes “Frontal” only
13	8.3.3 (p. 31)	An imaginary horizontal line BB through the center of the eyes shall be located between 50% and 70% of the vertical distance up from the bottom edge of the captured image	8.3.3 (p. 28)	The vertical distance BB, denoting the vertical distance from the bottom edge of the image of an imaginary horizontal line passing through the centre of the eyes, shall be between 50% and 70% of the total vertical length B of the image. A single exception is allowed for children under the age of 11 years, in which case the lower limit shall be modified to 40%.

14	8.3.4 (p. 31)	... The minimum (Image Width : Head Width) ratio (A:CC) is 7:4 .	8.3.4 (p. 28)	... To assure that the entire face is visible in the image, the minimum image width shall be specified by the (Image Width : Head Width) ratio (A:CC) of 7:5 .
15	-	None	8.3.6 Table 15 (p. 29)	Summary of photographic requirements for Full Frontal Images
16	9.2.3 Table 14 (p. 33)	X coordinate of First (right) Eye = $(0.375 * W) - 1$	9.2.3 Table 16 (p. 30)	X coordinate of First (right) Eye = $0.375 * W$

2.3 Migration from ANSI INCITS 385-2004 to ISO/IEC 19794-5

Since data records conformant to the ANSI INCITS 385-2004 or the ISO/IEC 19794-5 standards have an identical structure, and both of their Format Identifiers have the same values ('F' 'A' 'C' 0x0) and the same Version Numbers ('0' '1' '0' 0x00), they can be difficult to distinguish from one another. One of the possible ways of migration from an ANSI INCITS 385-2004 data record format to the ISO/IEC 19794-5 format would be an ability to read the "Format Owner" or "Format Type" values from the CBEFF Biometric Data Block (BDB) mandatory fields to distinguish which of the two formats the data record is in. Table 3 lists the values of "Format Owner" and "Format Type" that have been assigned by SC 37 to the ANSI INCITS 385-2004 and the ISO/IEC 19794-5 standards.

Table 3. "Format Owner" and "Format Type" Values

Standard	ANSI INCITS 385-2004	ISO/IEC 19794-5
Format Owner	0x001B	0x0101
Format Type	0x0501	0x0008

After the value of "Format Owner" from section 2.2 is identified, the conversion from ANSI INCITS 385-2004 to ISO/IEC 19794-5 still presents differences that need to be considered (the bolded areas demonstrate the differences):

- Gender Flags/Codes (Section 5.5.3 Gender)

Description	ANSI INCITS 385-2004	ISO/IEC 19794-5
Unspecified	0	0x00
Male	1	0x01
Female	2	0x02
Unknown	3	0xFF

The flags for "Unknown" in the ANSI INCITS 385-2004 standard could be converted from "3" to "255 (0xFF)".

- Eye Color Flags/Codes (Section 5.5.4 Eye Color)

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Description	ANSI INCITS 385-2004	ISO/IEC 19794-5
Unspecified	0x00	0x00
Black	None	0x01
Blue	0x01	0x02
Brown	0x02	0x03
Gray	None	0x04
Green	0x03	0x05
Hazel	0x12	None
Maroon	0x22	None
Multi-colored	0x10	0x06
Pink	0x20	0x07
Other or Unknown (<i>e.g.</i> , cannot be determined from image, monochrome image)	0xFF	0xFF

The flags of “Blue,” “Brown,” “Green,” “Multi-colored,” and “Pink” from ANSI INCITS 385-2004 could be converted to the equivalent pre-defined codes in ISO/IEC 19794-5. However, the flags of “Hazel” and “Maroon” from ANSI INCITS 385-2004 have no equivalent codes in ISO/IEC 19794-5 that could be used for conversion.

- Hair Color Flags/Codes (Section 5.5.5 Hair Color)

Description	ANSI INCITS 385-2004	ISO/IEC 19794-5
Unspecified	0x00	0x00
Bald	0x01	0x01
Black	0x02	0x02
Blonde	0x03	0x03
Brown	0x04	0x04
Gray	0x05	0x05
Red	0x06	0x07
Blue	0x10	None
Green	0x20	None
Orange	0x30	None
Pink	0x40	None
Sandy	0x13	None
Auburn	0x14	None
White	0x15	0x06
Strawberry	0x16	None
Reserved	None	0x08-0xFE
Unknown or Other	0xFF	0xFF

The flags of “Red” and “White” from ANSI INCITS 385-2004 could be converted to the equivalent pre-defined codes in ISO/IEC 19794-5. However, the flags of “Blue,” “Green,” “Orange,” “Pink,” “Sandy,” “Auburn,” and “Strawberry” from ANSI INCITS 385-2004 have no equivalent codes in ISO/IEC 19794-5 that could be used for conversion.

- Feature Flags/Property Flags (Section 5.5.6 Feature/Property Mask)

Description	ANSI INCITS 385-2004	ISO/IEC 19794-5
Features/Properties are specified	0	0
Glasses	1	1
Moustache	2	2
Beard	3	3
Teeth visible	4	4
Blink (either or both eyes closed)	5	5
Mouth open	6	6
Left Eye Patch	7	7
Right Eye Patch	8	8
Both Eye Patch	9	None
Dark Glasses (medical)	10	9
Major Medical Condition (that could impact feature point detection)	11	10
Reserved for future definitions	12-23	11-23

The flags of “Dark Glasses” and “Major Medical Condition” from ANSI INCITS 385-2004 could be converted to the equivalent pre-defined codes in ISO/IEC 19794-5. However, the flag of “Both Eye Patch” from ANSI INCITS 385-2004 has no equivalent code in ISO/IEC 19794-5 that could be used for conversion.

- Facial Feature Block (Section 5.6.3 The Facial Feature Block Encoding)

While the notes of “X” and “Y” coordinates from the ANSI INCITS 385-2004 mention that both counts start at 1, the ISO/IEC 19794-5 notes that they start at 0. The positions of facial features should subtract 1 from both coordinates from the ANSI INCITS 385-2004 format data record when those data are migrated to the ISO/IEC 19794-5 format.

- Facial Image Type (Section 5.7.1 Facial Image Type)

Description	ANSI INCITS 385-2004	ISO/IEC 19794-5
Basic	0	0x00
Full Frontal	1	0x01
Token Frontal	2	0x02
Other	3	None

Reserved	4-255	0x03-0xFF
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While ANSI INCITS 385-2004 defines the “Other” type (value = 3) under the “Basic” type, ISO/IEC 19794-5 has no equivalent code that could be used for conversion.

- Position of Eyes (Section 8.3.3 Position of Eyes)

The ANSI INCITS 385-2004 format has no definition to cover the vertical position of the face captured from children under the age of 11, while ISO/IEC 19794-5 defines that an imaginary horizontal line through the center of the eyes shall be located between 40% and 70% of the vertical distance up from the bottom edge of the captured image.

- Minimum (Image Width : Head Width) ratio (Section 8.3.4 Width of Head)

While the minimum (Image Width : Head Width) ratio from ANSI INCITS 385-2004 is **7:4**, ISO/IEC 19794-5 specifies that ratio as **7:5**.

Table 4 lists the summary of the migration readiness from ANSI INCITS 385-2004 to ISO/IEC 19794-5.

Table 4. The Summary of the Migration Readiness

Section #	Migration Readiness	Notes
5.5.3 Gender	Yes	
5.5.4 Eye Color	Partial	See above
5.5.5 Hair Color	Partial	See above
5.5.6 Feature Mask	Partial	See above
5.6.3 Facial Feature Block Encoding	Yes	
5.7.1 Facial Image Type	Partial	“Other” type could not be migrated
8.3.3 Position of Eyes	Yes	The range 40-70% includes 50-70%.
8.3.4 Width of Head	No	Conformance testing might fail
Other sections	Yes	

3 Conclusions, Recommendations, and Future Work

1. There are inconsistencies between the ANSI INCITS 385-2004 and ISO/IEC 19794-5 standards in several tables and/or clauses where values that are defined in one standard do not exist or are defined differently in the other. Possibly, new fields in the data format structure or in a CBEFF Patron Format should be created to close these gaps.
2. The CBEFF Format Owner or Format Type field can be used to determine whether a facial image interchange data record is in the ANSI INCITS or ISO/IEC format.
3. A given facial image record may or may not be convertible from the ANSI INCITS format into the ISO/IEC format. This is due to that fact that some values (for example Blue Hair) that are defined in ANSI INCITS do not exist in ISO/IEC. If, during the creation of facial image records, the values in ANSI INCITS that do not exist in ISO/IEC are avoided, the future data format conversion can be facilitated. Listed below are the values in the ANSI INCITS format that should not be used if the record may need to be converted at some point since they do not exist in the ISO/IEC format.

Eye Color Flags/Codes

Hazel	0x12
Maroon	0x22

Hair Color Flags/Codes

Blue	0x10
Green	0x20
Orange	0x30
Pink	0x40
Sandy	0x13
Auburn	0x14
Strawberry	0x16

Feature Flags/Property Flags

Both Eye Patch	9
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Facial Image Type

Other	3
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4. One other area of potential concern for data format conversion is the width of the head. The ANSI INCITS format allows for a 7:4 image to head width ratio whereas ISO/IEC requires at least a 7:5 ratio. Care should be taken to ensure captured photos have at least a 7:5 image to head width ratio since this keeps the image valid if its record is ever converted from the ANSI INCITS format into the ISO/IEC format.

5. If an ANSI INCITS facial image record does not have any aspects that go against the ISO/IEC standard (as described above) then an automated tool could be used that would convert the valid ANSI INCITS format record into a valid ISO/IEC format record. However, if a given record does have aspects that are valid under ANSI INCITS but are not valid in the ISO/IEC format, then that record could not be converted.
6. Future work should include development of a tool to identify ANSI INCITS 385-2004 data interchange format records and convert them to ISO/IEC 19794-5 data records.

Appendix A: List of Acronyms and Abbreviations

Acronym	Definitions
ANSI	American National Standards Institute
BTF	Biometrics Task Force
CBEFF	Common Biometric Exchange File Format
DoD	Department of Defense
INCITS	International Committee for Information Technology Standards
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
NIST	National Institute of Standards and Technology

Appendix B: References

1. ANSI INCITS 385-2004 Face Recognition Format for Data Interchange
2. ISO/IEC 19794-5 Biometric Data Interchange Formats – Part 5: Face Image Data
3. NISTIR 6529-A CBEFF Common Biometric Exchange Formats Framework